

REMARKS

Claims 1-30 are pending. Claims 1-7, 16-19, 23-25, 27-28 and 30 are withdrawn, leaving claims 8-15, 20-22, 26 and 29 active.

Claims 8-9 and 11-12 are rejected as anticipated by Kim, U.S. 5,524,118.

Claim 8 is an independent claim and has been amended to incorporate the subject matter of claim 9. Claim 9 has been cancelled. Each of claims 11 and 12 depends from claim 8.

As to independent claim 8 of this group, the Examiner relies on the wavelengths λ_1 through λ_n shown in Fig. 3 of Kim to correspond to the claimed "a plurality of wavelengths". But the Examiner makes no mention as to which portion of Kim he relies on to disclose the claimed feature of "the total number of generated photons being constant". Claim 8 also now sets forth that the statistical distribution of photons in each mode complies with a thermal distribution. Applicants respectfully submit that Kim fails to disclose or suggest that the total number of generated photons is constant. The Examiner's assertion that Kim teaches this limitation lacks support. If the Examiner intends to rely on this point, he is respectfully requested to designate the portion of Kim on which he relies.

As set forth in claim 8, by oscillating multiple-wavelength coherent light, although the total number of generated photons complies with a Poisson distribution, the number of photons for the respective wavelengths complies with a thermal distribution and therefore quantum-mechanically inherently fluctuates in a disordered manner. The present invention takes advantage of such a chaotic fluctuation for secure communication. Kim neither discloses nor suggests such a unique feature.

The laser light generated by the laser oscillator, as recited in claim 8, provides the advantage of being able to shift the distribution between a stable state and a disordered state, and vice versa (third paragraph of page 7 of the Specification). In contrast, Kim merely discloses multiple-wavelength lasers which are not configured to and cannot

accomplish prevention of illicit activities such as wire-tapping. The multiple-wavelength lasers of Kim cannot accomplish a shift between a stable state and a disordered state.

Accordingly, the novel subject matter set forth in claim 8 is patentable and should be allowed. Each of the dependent claims 10-12, which recite further novel features of the invention, also should be allowed.

Claims 20-23 are rejected as anticipated by Frankel, U.S. 6,430,336.

Claim 21 depends from claim 20. Claim 22 is an independent claim, and claim 23 depends from claim 22.

The independent claims 20 and 22 have been amended in a manner similar to claim 8 in reciting that the total number of photons generated by the laser oscillator is constant. Claim 20 further sets forth that there is a thermal distribution of the photons. Therefore, the arguments presented above with respect to claim 8 also apply to claim 20.

With respect to claim 20, the Examiner notes the optical wavelength transmitter 116-1 shown in Fig. 1 of Frankel. However, Frankel merely discloses that each of the optical wavelength transmitters 116-1 through 116-N respectively generates a single wavelength λ_1 through a single wavelength λ_n . In contrast, the laser oscillators of the independent claims 20 and 22 recite a plurality of laser oscillators which output laser light oscillated simultaneously at a plurality of wavelengths. Using this feature, an advantage is achieved in that the distribution can easily be shifted between a stable state and a disordered state by multiplexing and demultiplexing the laser light generated by the laser oscillators. As a result, quantum-mechanical scrambling can be realized, and thus it is possible to prevent illicit activities such as wire-tapping (second paragraph from the bottom of page 7 through first paragraph of page 8 of the Specification).

Frankel only teaches a plurality of optical wavelength transmitters, each of which generates light of a single wavelength. Therefore, it is impossible for Frankel to realize prevention of illicit activities.

With respect to the "optical modulators" of claim 20, the Examiner refers to the phase modulators 118 of Frankel. However, as shown in Fig. 1 of Frankel, the phase

modulators 118-1 through 118-N perform phase modulation using different data, i.e., the respective encoded data 1 through encoded data N. The phase modulators of Frankel are clearly different from the claimed optical modulators which add identical data to the laser light.

The invention as set forth in claim 20 adds identical data to a number of different wavelengths, the number of the wavelengths being equal to a product of the number of the wavelengths generated by each laser oscillator and the number of the laser oscillators. Claim 20 also calls for a coupler that multiplexes the wavelengths to transmit a wavelength-multiplexed signal. As a result, it is difficult for an unauthorized person performing tapping to select the correct wavelengths.

To summarize, the present invention as set forth in claim 20 provides a plurality of wavelengths generated by each laser oscillator. From a practical point of view, these can be used as a secret information protocol as agreed on between a transmitting side and a receiving side, from among the large number of wavelengths included in the wavelength-multiplexed signal (second paragraph of page 13, second paragraph of page 14, etc., of the Specification). This cannot be realized by the structure of Frankel which performs modulation using different data for each different wavelength.

Further, as to independent claim 22, it is to be noted that the Examiner's analysis of this claim does not appear to correctly correspond to the subject matter set forth in the claim. The Examiner appears to have compared the recitation of claim 21 with the disclosure of Frankel.

The Examiner points out from Frankel the splitter 134, the odd and even wavelength groups, and the combiners 124, 126 and 132 shown in Fig. 1 of Frankel. However, the combiners of Frankel are provided in the transmitter. In contrast, claim 22 recites structural elements provided in the receiver.

Referring to the structure of Frankel's receiver, Frankel merely discloses that the splitter 134 generates N replicas of the wavelength-division multiplexed signal in which N wavelengths λ_1 through λ_n are multiplexed. The receiver filters 138-1 through 138-N respectively receive the generated N replicas and extract a single wavelength from

among the N wavelengths, i.e., any one of the wavelengths λ_1 through λ_n . In contrast, the selectors set forth in claim 22 select combinations of a plurality of simultaneously oscillated wavelength components.

Frankel fails to disclose or suggest the technical idea of simultaneously oscillating combinations of a plurality of wavelength components. In addition, the receivers shown in Figs. 1 and 7 of Frankel fail to disclose or suggest structure corresponding to the claimed selectors.

The receivers shown in Figs. 1 and 7 of Frankel have no structure that performs multiplexing. Therefore, Frankel fails to disclose or suggest the structure corresponding to the claimed coupler which multiplexes light of the selected combinations of a plurality of simultaneously oscillated wavelength components to thereby realize a shift from a disordered state to a stable state.

Accordingly, the independent claims 20 and 22 set forth novel and advantageous subject matter and these claims should be allowed. The dependent claims 21 and 23 also should be allowed.

Claims 10 and 13-15 are rejected as unpatentable over Kim. Claim 10, dependent from claim 8, is discussed above. Claims 13-15 depend from claim 11, which now depends from claim 8.

With respect to the invention as recited in claim 10, the Examiner asserts that claimed "semiconductor light amplifiers are very well known in the art and . . . One skilled in the art would have been motivated to employ semiconductor light amplifiers rather than the EDF amplifiers taught by Kim since semiconductor light amplifiers are less expensive and more readily available than EDF amplifiers. Therefore, it would have been obvious to one skilled in the art at the time the invention was made to employ semiconductor light amplifiers in the device of Kim."

However, there is a clear difference between the EDF amplifiers (EDFAs) employed in Kim and the semiconductor optical amplifier (SOA) recited in these claims. That is, the gain of the EDFAs is not uniform while the gain of the SOA is uniform. More specifically, if the EDFAs are used to oscillate multiple wavelengths, a plurality of

individual lasers would oscillate stably. In contrast, if the SOA is used to oscillate multiple wavelengths, mode competition is generated. As a result, although generated photons behave totally as a single mode, a chaotic anti-correlation among the modes is generated. The invention as recited in these claims takes advantage of chaotic fluctuation in the respective modes resulting from such a nature of the SOA to realize secure communication. Kim fails to disclose or suggest such a technical idea. Therefore, the novel subject matter of claims 10 and 13-15 also is patentable and these claims should be allowed.

Claims 26 and 29 are rejected as unpatentable over Frankel in view of Kim. Claim 26 is an independent claim and claim 29 depends from claim 26. Claim 26 has been amended in a manner similar to claim 8 to recite a transmitter that generates laser light oscillated simultaneously at a plurality of frequencies and the constant total number of photons in a thermal distribution. It also recites a plurality of band pass filters.

The Examiner points out the optical wavelength transmitter 116 shown in Fig. 1 of Frankel for the claimed laser resonator, the phase modulator 118 for the claimed optical modulator, the fiber span 114 for the claimed transmission path, and the receiver node 112 and the detector 140 for the claimed receiver.

However, as explained with respect to claim 20, each of the optical wavelength transmitters 116-1 through 116-N of Frankel merely transmits light of a single wavelength. Frankel fails to disclose or suggest the claimed laser resonator which generates photons by stimulated emission centering on "a plurality of windows" provided in a wavelength domain. In the same manner as claim 20, the claimed laser resonator of claim 26 makes it possible to prevent illicit activities such as wire-tapping, which cannot be realized by the structure of Frankel.

Moreover, Frankel merely discloses that the receiver filters 138-1 through 138-N respectively extract the wavelengths λ_1 through λ_n , and that the detectors 140-1 through 140-N respectively detect the extracted wavelengths λ_1 through λ_n to obtain data 1 through data N. Unlike the receiver of claim 26, Frankel does not demodulate data based on an optical signal having wavelength components corresponding to the plurality of windows contained in the signal light.

With respect to the optical negative feedback element set forth in claim 26, the Examiner asserts that "as discussed in the rejection of claims 8-15, Kim teaches that this type of transmitter is well known in the art". Among claims 8-15, only claim 8 recites that the total number of generated photons is constant based on a thermal distribution in the same manner as claim 26. As explained with respect to claim 8, Kim fails to disclose or suggest this novel limitation. Therefore, the aforementioned arguments with respect to claim 8 also apply to claim 26.

Accordingly, the novel subject matter of claim 26 and its dependent claim 29 is patentable and these claims should be allowed.

All of the active claims are clearly patentable and should be allowed.

The other art cited has been considered and is not deemed pertinent.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Prompt and favorable action is requested.

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Respectfully submitted,

By 

S. Peter Ludwig

Registration No.: 25,351

DARBY & DARBY P.C.

P.O. Box 5257

New York, New York 10150-5257

(212) 527-7700

(212) 527-7701 (Fax)

Attorneys/Agents For Applicant